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INTRODUCTION AND SUMMARY

The Commission’s Mid-Band Notice of Inquiry was an important first step in addressing the nation’s pressing need for additional unlicensed spectrum resources.¹ Commenters from all parts of the wireless industry—including network providers, equipment manufacturers, software companies, rural ISPs, and chipmakers, in addition to numerous 6 GHz licensed incumbents—responded with comments strongly supporting Commission action to open the 5925–7125 MHz band (the “6 GHz band”) to unlicensed wireless broadband operations, governed by rules that protect incumbent services. These comments point the way forward. The Commission should promptly adopt a Notice of Proposed Rulemaking (“NPRM”) that proposes to open the entire 6 GHz band to wireless broadband and seeks comment on specialized rules that protect existing licensees.

Section I of these reply comments describes the record’s clear evidence that the country needs additional mid-band spectrum to support unlicensed broadband. Commenters confirm that unlicensed technologies drive economic growth, investment, and innovation—and that unless the Commission substantially increases spectrum resources available for unlicensed broadband operations, consumers and businesses will suffer. Mid-band spectrum—particularly the 6 GHz band—has propagation characteristics and proximity to existing unlicensed operations that make it ideal to address this spectrum need.

Section II responds to the broad group of commenters, which includes 6 GHz incumbents in addition to unlicensed technology companies, that agree with the NOI’s call for an engineering-focused proceeding to develop rules to protect existing licensees. We recommend

¹ *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, FCC 17-104, 32 FCC Rcd. 6373 (2017) (“NOI”).

that the Commission adopt an NPRM that seeks comment on specialized interference-protection rules, on top of the generally applicable Part 15 rules, based on the industry's experience and expertise. The goal of this NPRM should be to specify workable sharing mechanisms, address those valid concerns that have made a subset of commenters hesitant to embrace more efficient spectrum use, and allow industry to more efficiently and intensively use the 6 GHz band. This section therefore proposes a set of specific technical approaches to protect incumbents in each of the 6 GHz sub-bands and recommends that the Commission seek comment on these proposals in the NPRM. Our companies are working to further respond to the comments of 6 GHz licensees through a technical study that will provide the Commission with an engineering basis for interference-protection mechanisms, which we will soon submit on the record.

We are committed to exploring interference-protection rules that protect incumbents, and we oppose calls by some commenters to instead clear portions the 6 GHz band of existing licensees. A realistic, broadly beneficial goal for the 6 GHz band is to permit more intensive use of the band while protecting incumbents—not to disruptively displace the current Fixed Service (“FS”), Fixed Satellite Service (“FSS”), Broadcast Auxiliary Service (“BAS”), and Cable Television Relay Service (“CARS”) users. An NPRM should propose tools for protecting incumbents, not efforts to supplant them.

Finally, Section III demonstrates that the record supports reforming 6 GHz incumbent registration databases. The Commission can best protect incumbents, and permit unlicensed use where there are no incumbent operations, by knowing where and how incumbents are operating.

In the NPRM, the Commission should, therefore, propose to create a mechanism that results in incumbent licensees correcting errors and omissions in the Commission's records so that unlicensed operators protect licensees effectively.

I. A WIDE RANGE OF COMMENTERS HAVE DEMONSTRATED THE PRESSING NEED FOR ADDITIONAL MID-BAND UNLICENSED SPECTRUM FOR WIRELESS BROADBAND.

A broad group of industry leaders, including broadcasters,² mobile and wireless service providers,³ chip and device manufacturers,⁴ technology companies,⁵ standards bodies,⁶ trade

² Comments of the North American Broadcasters Association at 1, 7 (filed Sept. 29, 2017) ("NABA Comments"). Unless otherwise noted, all comment citations herein are to comments filed on October 2, 2017 in GN Docket No. 17-183 in response to the Commission's Notice of Inquiry dated August 3, 2017.

³ Comments of Charter Communications, Inc. at 2–3 ("Charter Comments"); Comments of Ericsson at 2–3, 9 ("Ericsson Comments"); Comments of T-Mobile USA, Inc. at 16 ("T-Mobile Comments"); Comments of Verizon at 21–22 ("Verizon Comments"); Comments of Vivint Wireless, Inc. at 2–4 ("Vivint Comments").

⁴ Comments of Bluetooth Special Interest Group, Inc. at 2 ("Bluetooth Comments"); Comments of Broadcom, Ltd. at 1 ("Broadcom Comments"); Comments of Cisco Systems, Inc. at 1 ("Cisco Comments"); Comments of Federated Wireless, Inc. at 11–12 ("Federated Wireless Comments"); Comments of Hewlett Packard Enterprise at 8 ("HPE Comments"); Notice of Inquiry Comments of Intel Corporation at 2 ("Intel Comments"); Comments of Qualcomm Incorporated at 1 ("Qualcomm Comments").

⁵ Comments of All Points Broadband, Amplex Internet, Apple, Blaze Broadband, Cambium Networks, Cisco Systems, Cypress Semiconductor, Dell, Extreme Networks, Facebook, Fire2Wire, Google, Hewlett Packard Enterprise, HP, Intel, Joink, MediaTek, MetaLINK Technologies, Microsoft, New Wave Net, Pixius Communications, Qualcomm, Rise Broadband, Ruckus, a Unit of Brocade, Snappy Internet, Sony Electronics, Western Broadband, Wireless Internet Service Provider Association, & Wisper ISP at 1 ("Wireless Broadband Industry Comments"); Comments of Comsearch at 5 ("Comsearch Comments"); Comments of Google LLC & Alphabet Access at 1–3 ("Google Comments"); Comments of Microsoft Corporation at 2 ("Microsoft Comments"); Comments of NetMoby, Inc. at 8; Comments of Zodiac Inflight Innovations at 1–2 (filed Sept. 29, 2017) ("Zodiac Comments").

⁶ Comments of IEEE 802 at 4 ("IEEE 802 Comments"); Comments of the IEEE Dynamic Spectrum Access Networks Standards Committee ("DySPAN-SC") on Expanding Flexibility in the Spectrum Between 3.7 and 24 GHz Via the Use of Spectrum Consumption Models at 2.

organizations and alliances,⁷ and the public and non-profit sectors⁸ support the Commission’s proposal to open additional mid-band spectrum for wireless broadband. Notably, these include wireless internet service providers and other incumbents with significant investments in existing licensed 6 GHz services. As those comments emphasize, unlicensed technologies generate substantial social and economic value, but the demand for unlicensed spectrum is beginning to exceed its supply. Unless the Commission makes substantial new unlicensed spectrum available, those benefits are in jeopardy. The record shows that the 6 GHz band presents a unique opportunity to head off that shortage before it undermines economic growth.

A. Unlicensed Technologies Drive Economic Growth, Investment, and Innovation.

The record in this proceeding demonstrates that unlicensed technologies contribute significantly to the U.S. economy and drive investment and innovation. They have become central to the operations of a wide variety of industries, generating significant social and

⁷ Comments of the Computing Technology Industry Association (“CompTIA”) at 1 (“CompTIA Comments”); Comments of CTIA at 1–3 (“CTIA Comments”); Comments of Dynamic Spectrum Alliance at 1, 10–11 (“DSA Comments”); Comments of the Information Technology Industry Council at 1–2 (“ITI Comments”); Comments of the Mid-Band Spectrum Coalition at 2 (“Mid-Band Coalition Comments”); Comments of the National Spectrum Management Association at 14 (“NSMA Comments”); Comments of NCTA – The Internet & Television Association at 2 (“NCTA Comments”); Comments of the Telecommunications Industry Association at 1; Comments of Wi-Fi Alliance at 1 (“Wi-Fi Alliance Comments”); Comments of the Wireless Broadband Alliance at 2 (“Wireless Broadband Alliance Comments”).

⁸ Comments of the State of Maryland at 6 (“Maryland Comments”) (“Maryland welcomes the Commission’s desire to make additional ‘mid-band’ spectrum available for carriers, manufacturers, and others delivering broadband to rural and underserved areas.”); Comments of the National Academy of Sciences’ Committee on Radio Frequencies at 1 (“NAS Comments”) (“CORF generally supports the sharing of ‘flexible use’ of frequency allocations where practical”); Letter from Harold Feld, Senior Vice President, Public Knowledge, to Marlene H. Dortch, Secretary, Federal Communications Commission, at 2, GN Docket No. 17-183 (filed Oct. 2, 2017) (“Public Knowledge Ex Parte”).

economic value. The development of 5G will make the contributions of unlicensed technologies even more significant.

Numerous commenters highlight how Wi-Fi and other unlicensed technologies have become integral to a wide variety of industries. Broadcom notes that “unlicensed spectrum is unique in that it allows truly ubiquitous deployment in both public and private networks—ranging from large operator deployments in stadiums, to home networks that serve as the last-100-foot connection between consumers’ devices and the Internet.”⁹ Furthermore, Hewlett Packard Enterprise explains that “Wi-Fi and other unlicensed services like z-wave, Bluetooth, and RFID have become central to the entire U.S. supply chain,” playing roles not only in online purchasing but in factories, distribution centers, and fulfillment centers nationwide.¹⁰

Commenters also describe the role of Wi-Fi networks in the military, assisting with deployments and aircraft readiness, and keeping service members connected to their families; in hospitals, providing real-time access to patient medical data as well as “pervasive connectivity throughout the hospital to ease monitoring and improve data reporting;” and in the education system, because “public Wi-Fi often plays a critical role in addressing the homework gap” by giving some students their only access to high-speed internet.¹¹

Wi-Fi’s critical role in these enterprises is no surprise, given its ubiquity in American life. Wi-Fi “is *the* most universally accepted unlicensed application” and “the predominant on- and off-ramp for Internet access from U.S. homes and businesses.”¹² Through their increasing

⁹ Broadcom Comments at 3.

¹⁰ HPE Comments at 4–5; *see also* Broadcom Comments at 6.

¹¹ HPE Comments at 6–8; *see also* Broadcom Comments at 5.

¹² Wi-Fi Alliance Comments at 3, 5.

centrality in the lives of individuals and in industries of all kinds, unlicensed technologies contribute substantial social and economic value. The Dynamic Spectrum Alliance (“DSA”) notes that unlicensed technologies are projected to “contribute \$547 billion in economic value and nearly \$50 billion to the GDP” in 2017 alone.¹³

Recent emergencies also underscore unlicensed technologies’ importance to the country. NCTA explains, for example, that “Wi-Fi networks play an important role in keeping people connected, including in the wake of natural disasters,” where they “can help people to contact emergency services and loved ones when other means of communication are unavailable.”¹⁴ Broadcom illustrates this point by reference to Hurricane Irma: when 80 percent of cell phone towers in some Florida counties were taken offline by Irma’s destruction, “Wi-Fi providers stepped in to help, with Comcast opening up free public access to more than 137,000 of its Xfinity Wi-Fi hotspots throughout Florida.”¹⁵

Wi-Fi also serves as a crucial complement to licensed wireless services. Licensed carriers emphasize that “future growth in mobile broadband connections—and exponential growth in the consumption of data by those connections—can only be accommodated by regular infusions of additional spectrum.”¹⁶ However, as the Mid-Band Spectrum Coalition points out, “the

¹³ DSA Comments at 13; *see also* Broadcom Comments at 4; HPE Comments at 4.

¹⁴ NCTA Comments at 5–6.

¹⁵ Broadcom Comments at 5–6.

¹⁶ Comments of AT&T Services, Inc. (“AT&T Comments”) at 2; *see also* T-Mobile Comments at 5 (“Consumers, on average, spend over two and [a] half hours each day on mobile devices—twice the amount of time spent at a desktop computer—accessing data-intensive applications, such as video and the Internet for communication and entertainment.”); Verizon Comments at 4 (“[G]rowth in data usage . . . is only increasing as smartphone usage becomes nearly ubiquitous and data-intensive applications become more common and more inextricably merged with our everyday lives.”).

[unlicensed] share of offloaded data will grow to 70% by 2021.”¹⁷ In fact, this might be a significant underestimate. In 2016, AT&T’s President of Network Operations indicated that the company was already routing 4 million calls a day over Wi-Fi and that “[a]bout 80 percent of the wireless traffic today is handled over Wi-Fi networks.”¹⁸ In any case, as mobile data consumption grows, the portion of that data that traverses unlicensed spectrum is expected to grow with it.

Unlicensed technologies stand to become even more significant when operators begin to deploy 5G networks, which will be “a combination of licensed and unlicensed technologies, with Wi-Fi technology playing a leading role.”¹⁹ As Federated Wireless explains, “[a]ccess to shared and unlicensed spectrum will extend 5G in multiple dimensions” and “support[ing] all spectrum types . . . creates opportunities for new innovation to take spectrum sharing to the next level in 5G.”²⁰ Unlicensed technologies’ critical role in 5G deployment will further magnify the economic impact of Commission unlicensed spectrum policy. As the Mid-Band Spectrum Coalition, which includes T-Mobile, Verizon, Ericsson, Nokia, and CTIA, acknowledges, the latest 3GPP standards for 5G include Wi-Fi and operators are expected to “heavily leverage”

¹⁷ Mid-Band Coalition Comments at 8 n.16.

¹⁸ Diana Goovaerts, *AT&T: We’re Carrying 4M Calls Per Day Over Wi-Fi*, Wireless Week (June 21, 2016, 4:19 PM), <https://www.wirelessweek.com/news/2016/06/t-were-carrying-4m-calls-day-over-wi-fi>.

¹⁹ NCTA Comments at 8 (quoting Wireless Broadband Alliance, *5G Networks: The Role of Wi-Fi and Unlicensed Technologies* 3 (2017), <https://www.wballiance.com/resources/wba-white-papers>).

²⁰ Federated Wireless Comments at 8 (quoting Qualcomm, *5G Spectrum Sharing Brings New Innovation*, <https://www.qualcomm.com/invention/technologies/5g-nr/spectrum-sharing> (last visited Oct. 26, 2017)).

unlicensed spectrum in 5G networks.²¹ In short, 5G will be hobbled without additional unlicensed spectrum.

B. Without Substantial New Unlicensed Spectrum, Consumers and Businesses Will Suffer Service Degradation as Data Use Increases.

Commenters also agree that, unless the Commission designates substantial new unlicensed spectrum soon, individuals and businesses nationwide will experience service degradation,²² threatening the continued economic value produced by unlicensed services.²³ Already, consumers and businesses cannot use unlicensed technologies optimally because the United States lacks sufficient unlicensed spectrum. DSA observes that “Wi-Fi users already experience interference and slow speeds during the peak busy hour across the country.”²⁴ Moreover, many commenters cite studies that illustrate that, considering the predictable increase in unlicensed usage alongside widespread adoption of new data-intensive applications, this existing deficiency is expected to snowball into an unlicensed spectrum challenge within the next

²¹ Mid-Band Coalition Comments at 10.

²² See Broadcom Comments at 4–5; Cisco Comments at 3–4; CompTIA Comments at 1; DSA Comments at 11–12, 21–22; Ericsson Comments at 1–2; Federated Wireless Comments at 2; HPE Comments at 3, 8; IEEE 802 Comments at 4; Intel Comments at 2–4; ITI Comments at 2–3, 5; Mid-Band Coalition Comments at 9; NCTA Comments at 6; Qualcomm Comments at 8; Wi-Fi Alliance Comments at 2; Wireless Broadband Alliance Comments at 7–9; *see also* Wireless Broadband Industry Comments at 7.

²³ See Wi-Fi Alliance Comments at 5 (noting that the lack of available spectrum for Wi-Fi “threatens its ability to continue to deliver significant socioeconomic benefits and foster innovation”); *see also, e.g.*, T-Mobile Comments at 4 (“Identifying new spectrum for wireless broadband services is vitally important to continue . . . U.S. leadership in the wireless industry and the accompanying economic growth it produces.”); Verizon Comments at 2–3 (“The [f]ederal government should make more spectrum available, especially in the 3.5–24 GHz range, in order to avoid a spectrum shortage that would inhibit the growth, investment, and innovation in the wireless industry that has greatly benefited the American consumer.”).

²⁴ DSA Comments at 11.

few years.²⁵ DSA, for example, explains that the shortfall identified in a study by Quotient “necessitates at least doubling, and perhaps increasing by more than four-fold, available spectrum for unlicensed technologies.”²⁶ Ericsson reports that “mobile data usage in North America is expected to increase five-fold between 2016 and 2022,” and “[IoT] connections are projected to increase by more than 200 percent.”²⁷ And the IEEE 802 highlights projections from Cisco’s recent VNI: “Live video is expected to grow 15 times,” “[v]ideo surveillance is expected to grow seven-fold,” and “[c]onsumer Video on Demand (‘VoD’) will nearly double” between 2016 and 2021.”²⁸ A failure to accommodate these skyrocketing data needs will result in service degradation—slower speeds and intermittent connectivity.

C. Mid-Band Spectrum, Particularly the 6 GHz Band, Is the Optimal Site for Expanding Unlicensed Wireless Broadband Access.

To address the looming unlicensed spectrum crisis, commenters identify mid-band spectrum as the optimal site for expansion.²⁹ Mid-band spectrum is ideal for unlicensed use

²⁵ *Id.* at 11–12; Broadcom Comments at 5; HPE Comments at 3; IEEE 802 Comments at 6; Mid-Band Coalition Comments at 8 & n.16; NCTA Comments at 6–7; Wi-Fi Alliance Comments at 5–6; Wireless Broadband Alliance Comments at 7–8; *see also* Wireless Broadband Industry Comments at 7; Ericsson Comments at 1–2 (discussing the growth of Internet of Things connections).

²⁶ DSA Comments at 11–12.

²⁷ Ericsson Comments at 1–2.

²⁸ IEEE 802 Comments at 5.

²⁹ Bluetooth Comments at 2–3; Broadcom Comments at 1; Charter Comments at 3 (“Given their close proximity to spectrum bands with either existing wireless broadband operations or where significant wireless broadband testing is underway, the 3.7 and 6 GHz bands offer great potential for expanding and enhancing existing wireless broadband use.”); CompTIA Comments at 2; Ericsson Comments at 3, 9; Google Comments at 2; HPE Comments at 9, 13; Intel Comments at 5; Maryland Comments at 2; Microsoft Comments at 10; Mid-Band Coalition Comments at 2, 5, 12; Comments of MVDDS 5G Coalition at 1 (“MVDDS Comments”); NCTA Comments at 9; NSMA Comments at 14; Public Knowledge Ex Parte at 2; Qualcomm Comments at 6–7; T-Mobile Comments at 7; Verizon Comments at 21; Vivint Comments at 2 (“Enabling more flexible access to mid-band frequencies will have

because of the band’s favorable propagation characteristics, proximity to existing unlicensed operations, and ability to support the wide channels that advanced applications and gigabit services require.

First, mid-band spectrum’s propagation characteristics make it ideal for unlicensed operations. For example, Microsoft notes that, unlike higher-band unlicensed spectrum, mid-band spectrum’s longer wavelengths allow it to penetrate indoor walls.³⁰ Mid-band spectrum is therefore ideal for indoor unlicensed operations that move large files around homes and offices. Furthermore, T-Mobile notes that “[t]his proceeding fills the missing piece” of spectrum policy by proposing to open mid-band frequencies, which offer physical characteristics that provide “a balance of capacity and coverage.”³¹

Second, mid-band spectrum’s potential for “deep integration”³² with the 5 GHz band—which is the most important and dynamic unlicensed band today—will allow unlicensed operators to maximize economies of scale³³ by “leverag[ing] the existing 5 GHz Wi-Fi

dramatic and immediate benefits for Vivint and other providers of fixed wireless broadband services.”); Wireless Broadband Alliance Comments at 16–17; Zodiac Comments at 2 (“[Reallocating the 6 GHz band] for unlicensed use by short range devices would be a boon to the aviation industry and the traveling public.”); *see also* Wireless Broadband Industry Comments at 2, 9–10.

³⁰ Microsoft Comments at 10.

³¹ T-Mobile Comments at 7. Likewise, although ultimately advocating that the Commission open a different frequency range, the MVDDS 5G Coalition explains that “mid-band spectrum . . . promises to serve as a critical foundation for fifth-generation mobile broadband services (“5G”) because the spectrum combines the favorable coverage characteristics of lower-frequency bands with the high-capacity capability of high-frequency spectrum.” MVDDS Comments at 1.

³² Broadcom Comments at 1.

³³ *Id.* at 4, 9; DSA Comments at 12–13; HPE Comments at 13; Intel Comments at 2; Mid-Band Coalition Comments at 12; Microsoft Comments at 5, 11; Qualcomm Comments at

infrastructure.”³⁴ For example, DSA points out that “semiconductor and device manufacturers can rapidly add the 6 GHz band to an existing Wi-Fi ecosystem, speeding availability of new technology, allowing greater efficiency, and reducing costs.”³⁵ That is so, NCTA explains, because “existing radio components could simply be modified to permit operations in the new band rather than new components developed.”³⁶ IEEE foresaw the benefits of integrating the 6 GHz band with the 5 GHz device ecosystem and has already initiated “efforts to extend the next version of their standards to encompass the new [6 GHz] band.”³⁷ Broadcom explains that these efforts eliminate the “need for a lengthy new standards setting process before 6 GHz Wi-Fi could reach the market.”³⁸ Leveraging economies of scale in this way both produces cost savings and facilitates more rapid adoption of new spectrum allocations, thereby driving economic growth and tackling the spectrum crisis more quickly.

Third, the 6 GHz band’s proximity to existing operations will allow operators to create the wide channels that are “increasingly important for the state-of-the-art applications and services . . . that include ultra-HD video streaming, gaming, as well as augmented and virtual

17; Wi-Fi Alliance Comments at 7; *see also* Wireless Broadband Industry Comments at 18–19.

³⁴ Microsoft Comments at 10.

³⁵ DSA Comments at 12.

³⁶ NCTA Comments at 9; *see also* Microsoft Comments at 10; Qualcomm Comments at 8, 9–10 (“[T]he wireless components used to support unlicensed broadband operations at 5 GHz can readily be extended to or reused for 6 GHz band operations—assuming that the Commission rules for 6 GHz unlicensed broadband are technically compatible with the 5 GHz U-NII rules.”).

³⁷ DSA Comments at 12–13.

³⁸ Broadcom Comments at 9.

reality experiences.”³⁹ Those wide channels, Microsoft notes, can also facilitate faster gigabit speeds.⁴⁰ Similarly, Public Knowledge argues that the 6 GHz band “creates the best chance of creating a large band of contiguous spectrum which will allow next generation 5G Wi-Fi to be deployed in the United States.”⁴¹ Wireless Broadband Alliance also emphasizes that this contiguous spectrum enables unlicensed devices to spread throughout the band, allowing them to “maintain a lower overall power spectral density . . . which will greatly enhance the sharing environment.”⁴² Taken together, these characteristics make mid-band spectrum, and particularly the 6 GHz band, most appropriate for expanded unlicensed operations.

II. THE COMMISSION SHOULD ADOPT AN NPRM THAT PROPOSES TO PERMIT UNLICENSED BROADBAND OPERATIONS IN THE ENTIRE 6 GHz BAND.

A. A Broad Range of Commenters Support the NOI’s Focus on Finding Technical Solutions to Protect 6 GHz Incumbents.

A wide range of broadband providers, technology companies, and semiconductor manufacturers support Commission action to identify appropriate mechanisms to protect incumbents.⁴³ By issuing an NPRM that draws on and invites the technical expertise of stakeholders from across the industry, the Commission can identify the most effective sharing

³⁹ Qualcomm Comments at 6–7.

⁴⁰ Microsoft Comments at 10.

⁴¹ Public Knowledge Ex Parte at 2.

⁴² Wireless Broadband Alliance Comments at 17.

⁴³ *Id.* at 12; Charter Comments at 2–3; Cisco Comments at 2; CompTIA Comments at 2–3; Comsearch Comments at 3–5; Ericsson Comments at 3, 9; Federated Wireless Comments at 9–11; Comments of the Fixed Wireless Communications Coalition at 6–11; Google Comments at 2; IEEE 802 Comments at 4; ITI Comments at 4–5; Intel Comments at 1, 5; Microsoft Comments at 9–10 & n. 16, 12; Mid-Band Coalition Comments at 13–14; NCTA Comments at 4–5; Comments of Nokia at 15–16 (“Nokia Comments”); Public Knowledge Ex Parte at 2; Qualcomm Comments at 6–7; T-Mobile Comments at 17–18; Vivint Comments at 4; Wi-Fi Alliance Comments at 2; Zodiac Comments at 2.

solutions, encourage technical coordination between 6 GHz incumbents and unlicensed operators, and address concerns about sharing on the record and thereby allow more efficient use of a band that is underutilized in most of the country.

As numerous commenters have explained, the 6 GHz band is home to a variety of users and is, at least in some segments and in some geographies, heavily used.⁴⁴ But even with this use, the band is underutilized or unutilized in most of the country because even in communities where there is FS service, that service necessarily creates narrow beams that leave most of the geography and frequencies unused. To determine how wireless broadband can coexist with those incumbents and improve intensity of use, “engineering analysis and modeling must come first.”⁴⁵ The Commission should, therefore, use the NPRM to ask questions that leverage deep industry knowledge in order to “determine the incumbent emissions environment, and project how new transmitters could be introduced without harming those with superior spectrum rights.”⁴⁶

Importantly, many significant 6 GHz licensees have told the Commission that they will support unlicensed operations in the band if the Commission adopts rules that protect existing operations. The American Association of State Highway & Transportation Officials (“AASHTO”), for example, explains that “there may be techniques that could mitigate interference” in the 6 GHz band and that indoor Part 15 operations “would have little likelihood for interference potential to the Part 101 services AASHTO’s members use.”⁴⁷ Content

⁴⁴ See, e.g., Comments of the American Cable Association at 4; CTIA Comments at 15; Ericsson Comments at 9; Federated Wireless Comments at 11–12; Comments of the National Association of Broadcasters at 6.

⁴⁵ Cisco Comments at 2.

⁴⁶ *Id.*

⁴⁷ Comments of the American Association of State Highway & Transportation Officials at 3.

Companies, including The Walt Disney Company, CBS Corporation, Scripps Networks Interactive, Inc., Time Warner Inc., 21st Century Fox, Inc., and Viacom Inc., “welcome opportunities to improve [the] wireless broadband connectivity” that allows their users to consume content on a wide variety of devices, as long as new uses protect their existing C-Band distribution operations.⁴⁸ The National Academy of Sciences’ Committee on Radio Frequencies also “supports the sharing and flexible use of frequency allocations where practical,” provided that scientific operations, including the EESS and RAS observations in the 6.425–7.125 GHz band, can be adequately protected.⁴⁹ Likewise, the North American Broadcasters Association explains that it is “committed to efficient spectrum use” as long as it does not cause harmful interference to incumbent broadcasters.⁵⁰ And CTIA agrees that, if interference protections can be identified, “introducing unlicensed use in the band potentially offers important benefits.”⁵¹

The NPRM is not, however, the appropriate vehicle for evaluating issues raised by manufacturers of ultrawideband (“UWB”) equipment, which operates on an unlicensed basis in the 6 GHz band. UWB devices are authorized under Part 15 and, therefore, must accept interference from other operations in the band, including other unlicensed operations.⁵² But UWB manufacturers nonetheless argue that the Commission should not authorize unlicensed broadband use of the 6 GHz band because of potential interference with UWB devices.⁵³

⁴⁸ Comments of the Content Companies at 5.

⁴⁹ NAS Comments at 13.

⁵⁰ NABA Comments at 7.

⁵¹ CTIA Comments at 16; *see also* Verizon Comments at 21–22.

⁵² Although Part 15 permits UWB operations in the 6 GHz band, the technical rules currently in place do not allow for wireless broadband applications.

⁵³ *See* Reply Comments of Agilion GmbH, GN Docket No. 17-183 (filed Nov. 2, 2017) (“Agilion Reply Comments”); Reply Comments of NXP Semiconductors, GN Docket No.

Unlicensed technologies have a long history of coexistence in the various bands where Commission rules permits their operation. This sharing, both between devices using the same technology and devices using different unlicensed technologies, works in bands shared by different unlicensed technologies because of collaboration in open standards bodies, such as the IEEE. The standards setting process is therefore the appropriate venue for UWB interests to raise their concerns. In fact, many UWB operations are already governed by IEEE standards such as 802.15.4 IR-UWB,⁵⁴ and the IEEE has a long history of resolving interference concerns between unlicensed technologies. In addition, as the UWB manufacturers highlight, UWB radiolocation systems are commonly used to track objects and people indoors, or within enclosed venues such as stadiums, suggesting that any interference, e.g., from Wi-Fi to a UWB radiolocation system, could likely be managed by the venue owner. Notably, UWB systems currently operate co-channel with numerous *licensed* operators at far higher power levels and spectral densities.

Kicking off a cross-industry technical discussion will also help clear up misconceptions that may stand in the way of a compromise solution for sharing between unlicensed operations and incumbent licensees. For example, the National Spectrum Management Association has argued that existing radios can be impacted by transmitters as far as 250 miles away, “so there is no location in the United States where new radios could be placed that would not potentially affect existing fixed service users in the bands.”⁵⁵ This is a strawman argument that the Commission should reject, based on a premise that unlicensed proponents have explicitly rejected. No one has argued that the Commission should grant unlicensed technologies access to

17-183 (filed Nov. 2, 2017); Reply Comments of Zebra Technologies, GN Docket No. 17-183 (filed Nov. 3, 2017).

⁵⁴ See Agilion Reply Comments.

⁵⁵ NSMA Comments at 4–5.

the 6 GHz band without interference protections. Just as in the 5 GHz band, where the unlicensed industry supports mitigations tailored to address specific incumbent classes, the Commission should pay careful attention to incumbent operations and is gathering a strong analytical basis for proposed rules to protect those operations.

Similarly, some parties incorrectly suggest that the Commission’s decision to suspend pursuit of an unlicensed designation for U-NII-2(b) at this time means that unlicensed cannot work at 6 GHz.⁵⁶ The incumbent environment in the 5.4 GHz band, where the key sharing partner would have been federal radar, is completely different from the 6 GHz landscape where no radars are present. For the 6 GHz band, an on-the-record proceeding supported by engineering studies will allow the Commission to determine whether parties who believe that there is “no way” to protect incumbents no matter what sharing mechanism are adopted are mistaken, as we believe they are.⁵⁷

B. The Commission Should Propose U-NII Rules that Permit Unlicensed Broadband in the 6 GHz Band to Protect Incumbent Licensees.

To advance this process, we recommend that the Commission use the NPRM to propose to permit unlicensed operations throughout the 6 GHz band governed by mitigations to protect incumbents, on top of existing Part 15.5 protections, in each portion of that band: the proposed U-NII-5, U-NII-6, U-NII-7, and U-NII-8 bands.⁵⁸ U-NII rules tailored for operations in the 6 GHz band would protect each incumbent service while increasing overall efficiency by applying technical limits to the frequencies where they are required to prevent harmful

⁵⁶ Comments of the National Public Safety Telecommunications Council at 8; Comments of Tucson Electric Power Company at 5 (“Tucson Comments”).

⁵⁷ Tucson Comments at 5.

⁵⁸ *See, e.g.*, Wireless Broadband Industry Comments at 12 (proposing four unlicensed sub-bands).

interference, without over-regulating in areas or for use cases where a particular restriction is not required. To assist the Commission in developing specific rule proposals in the NPRM, our companies are preparing a technical study for the record that will include engineering analyses demonstrating that unlicensed broadband operations can be admitted into the 6 GHz band without creating harmful interference to incumbents.

We recommend that, in addition to client devices, indoor access points, and other fixed indoor devices, the Commission should propose to permit two types of outdoor devices in the U-NII-5 and U-NII-7 sub-bands:

- Low-power, outdoor fixed devices with a fixed gain limit, and an antenna height restriction.
- Higher-power, outdoor fixed devices, with a mandate that such devices (1) employ a mechanism for affirmatively restricting operation to locations and frequencies where they will not cause harmful interference to incumbents, (2) limit radiated power at elevation angles above 30 degrees in U-NII-5 to comply with antenna pointing restrictions and protect satellite incumbents, and (3) periodically transmit identifying information.

The Commission should define fixed devices as those which cannot operate unless attached to other fixed infrastructure, such as wired power connections, as it has done elsewhere,⁵⁹ and further require fixed 6 GHz devices to implement transmit power control. The proposed rules should take into account the important differences between indoor and outdoor devices and between low-power, high-power, and highly directional applications (including fixed point-to-point and point-to-multipoint) to maximize efficiency and intensity of spectrum use without risking harmful interference. The structure we propose would impose restrictions that are substantially more protective than in other bands where unlicensed operations are permitted, and are tailored to the particular incumbents in the 6 GHz band. The Commission should draw on the

⁵⁹ See 47 C.F.R. § 15.257(a)(i).

record generated in response to the NPRM to apply specific values within the regulatory structure detailed below. In addition, because of the special characteristics of the U-NII-8 band, we suggest that the Commission specifically solicit further comment in the NPRM on outdoor fixed operation in these frequencies, in order to explore protection mechanisms.

i. Fixed Outdoor Devices

The Commission should propose to permit fixed outdoor operations in U-NII-5, U-NII-7, and, subject to further inquiry, U-NII-8, with a different set of proposed rules for low power, high power, and highly directional operations, including fixed point-to-point and steerable point-to-point devices. The reason to consider the broadest swath of spectrum possible for outdoor operations is to increase the number of channels available and avoid concentrating outdoor transmissions. Simply put, where there are more spectrum options, there are greater mitigation options to reduce the potential for harmful interference.⁶⁰ The availability of tailored rules for these separate categories of devices would allow operators to protect licensees by choosing lower power in exchange for greater regulatory flexibility or to accept additional regulatory restrictions associated with higher power, thus allowing them to maximize the efficiency of their unlicensed uses while still protecting incumbents. As described below, each set of rules would provide robust protection for incumbents.

The Commission should propose to permit low-power fixed outdoor operations subject to highly protective, but simple-to-implement technical restrictions. This would provide a less technologically prescriptive option (for instance, so that small businesses can offer coverage within small outdoor areas adjacent to their indoor spaces), without the added complexity and

⁶⁰ For example, in the 5 GHz context, DFS master devices listen in the background for radar and therefore are aware of their environment. If they detect radar, those devices change channels.

potential expense that may be associated with higher-power outdoor operations. In addition to sharp limits on radiated power, the Commission should propose a fixed gain limit, and an antenna height restriction that will ensure that low-power deployments do not extend above the roofline.

The Commission should propose to subject other fixed operations, operating at higher power levels, to greater restrictions, including rules that require such operations to actively avoid locations and frequencies that might increase the risk of interference to incumbents.

First, to protect terrestrial incumbents, the Commission should propose that higher-power outdoor devices must implement a mechanism for affirmatively verifying, before transmitting, whether they could operate on a given channel, in a given location, without causing harmful interference to licensees. That mechanism would periodically obtain updates on licensee data from the Commission's licensing databases and then apply protection criteria to identify the necessary geographic and spectral keep-out zones needed to protect each licensee from harmful interference.

Second, to protect satellite incumbents, the proposed rules should require outdoor operations at reduced radiated power levels at elevation angles above 30 degrees in U-NII-5 to comply with antenna pointing restrictions similar to those that currently apply in U-NII-1,⁶¹ which have proven to be successful in preventing harmful interference to satellite uplinks.⁶² To

⁶¹ 47 C.F.R. § 15.407(a)(1)(i).

⁶² Although other 6 GHz bands are also used for satellite uplink, harmful interference from unlicensed operations is unlikely to affect satellite uplink performance on its own. Aggregation of unlicensed emissions and interference from other satellite uplinks—recognizing that other satellite transmissions produce far more energy than unlicensed devices would radiate upwards towards space—may, together, pose a somewhat higher, but very low risk of interference. This is why antenna pointing restrictions described above may therefore be appropriate in U-NII-5; interference from other satellite uplinks may be more

provide further protection, the Commission should propose that such operations would also not be permitted to point within 2 degrees of the geosynchronous equatorial orbit arc.

Third, the Commission should propose that higher-power outdoor devices must periodically transmit identifying information, and register this information in a database available to Commission licensees, to ensure that the Commission or licensees can quickly identify the operators of a device in the unlikely event that a licensee experiences harmful interference.

Furthermore, because of the special characteristics of the U-NII-8 band, we recommend that the Commission seek comment in the NPRM on outdoor operation in these frequencies to deepen its record. Specifically, the NPRM should inquire about the operations and use cases of U-NII-8 licensees, including whether and how often licensees use transmitters that change locations, how they use such transmitters, the current mix of local and longer-distance links, the technologies employed, and whether BAS operations other than Television Pick Up are mobile. With improved information, the Commission will be positioned to work with incumbents and unlicensed technology manufacturers to determine how to permit U-NII operations in this band.

ii. Indoor Access Points and Other Fixed Devices

The Commission should propose to permit fixed indoor operations in all four proposed 6 GHz sub-bands, at power levels higher than low-power fixed outdoor devices. The record almost surely will show that building loss will shield incumbents from any potential interference from indoor devices, compensating for any difference in the power levels of fixed indoor and

prevalent in this sub-band, thereby increasing overall potential interference. But they are unnecessary in other bands where satellite operations make less intensive use of uplink spectrum.

outdoor devices and—together with other operational restrictions—providing sufficient protection for incumbents throughout the 6 GHz band.

iii. Client Devices

The Commission should also propose to authorize client devices to operate in each 6 GHz sub-band, including U-NII-6, at power levels similar to those that currently apply to client devices in U-NII-1. These low transmit power levels (which likely will be below the regulatory limit in many cases, to preserve battery life), combined with the low antenna height and limited antenna gain of most client devices, will provide sufficient protections for 6 GHz incumbents.

iv. Device Security

Furthermore, the NPRM should propose to subject all unlicensed devices operating in the 6 GHz band to the same device security rules that the Commission currently uses to prevent circumvention of its dynamic frequency selection and other technical rules in the 5 GHz U-NII bands.⁶³ The Commission should also propose to extend its existing connectorization rules⁶⁴ to ensure that unlicensed 6 GHz devices cannot be used with antennas other than those supplied by the equipment manufacturer, consistent with the parameters of the device's certification and the Commission's technical rules.

C. The Commission Should Protect Incumbent Operations and Reject the Proposal to Clear the 6 GHz Band.

As stated in the NOI, the Commission's goal, rightly, is to increase the intensity of use of the 6 GHz band while protecting incumbent operations.⁶⁵ Permitting unlicensed operations, subject to the specialized restrictions described above, would accomplish this goal. But some

⁶³ See 47 C.F.R. § 15.407(a)(1)(i).

⁶⁴ 47 C.F.R. § 15.203.

⁶⁵ See NOI ¶¶ 1–2.

commenters ask the Commission to go much further and recommend displacing licensees from the majority of the band. The Commission should reject this proposal.

One commenter suggests that the Commission relocate 6 GHz FSS and FS incumbents to the 7.1–8.4 GHz band—or to fiber or some other service—so that the 6 GHz band can be auctioned for mobile use.⁶⁶ They also describe BAS and CARS as outmoded and state that they “can be eliminated” and replace with alternatives like 5G.⁶⁷ Similarly, another commenter urges the Commission “to transition incumbent operations out of the [6.425–7.125 GHz] band, either to another band or fiber” to clear the way for “other valuable usages, such as 5G.”⁶⁸

As an initial matter, it is not at all clear that adding licensed fixed and mobile services to 7.1–8.4 GHz is achievable. Sensitive federal uses in the band, which has become the new home of federal systems relocated from other frequencies, could substantially complicate a plan to add commercial licensed fixed and mobile use to the band. Moreover, these band-clearing proposals fail to account for the real-world costs and delays associated with clearing the band, including the disruption to users and displacement of investment associated with existing uses—particularly existing public safety services. As DSA points out, the Commission need look no further than its recent efforts to clear spectrum for FirstNet to see how slow and arduous evicting well-established incumbents can be.⁶⁹ A clearing strategy would substantially delay use of the 6 GHz band for wireless broadband operations. This is because even before the Commission can begin a multi-year clearing process, it must work through months or years of auction design and

⁶⁶ T-Mobile Comments at 18.

⁶⁷ *Id.* at 19.

⁶⁸ Ericsson Comments at 10.

⁶⁹ DSA Comments at 19.

related proceedings, and conduct an auction, all before mobile wireless operators could even begin moving into the band.⁷⁰ That delay would come at a significant opportunity cost at a time when consumers cannot afford delay. Conversely, amending the existing Part 15 rules to add complementary unlicensed broadband operations to the band—while continuing to “account for and protect . . . incumbent use”⁷¹—will respect incumbent operations, require far less time, and require fewer resources, therefore permitting the Commission to deliver new consumer benefits faster than any band-clearing strategy possibly could.

III. THE RECORD SUPPORTS REFORMING THE DATABASE OF INCUMBENT 6 GHz OPERATIONS.

No matter how the Commission decides to move ahead to increase utilization of the 6 GHz band, it will require accurate, up-to-date information on incumbent operations. To provide a proper foundation for incumbent-protection mechanisms, many commenters emphasize that the Commission’s information about current operations must more accurately reflect the identity and location of incumbent services.⁷² The Commission’s database must also contain accurate technical data, including basic characteristics such as transmitter and receiver locations, antenna heights, antenna class, and power levels.

Though complete information “is the only means for the Commission to truly evaluate current use and protection mechanisms,”⁷³ the record demonstrates that the Commission’s existing information about 6 GHz operations falls short. Several commenters have raised

⁷⁰ See Ericsson Comments at 10; HPE Comments at 9.

⁷¹ Wi-Fi Alliance Comments at 8.

⁷² See IEEE 802 Comments at 6; Microsoft Comments at 12; Wi-Fi Alliance Comments at 8.

⁷³ Michael O’Rielly, Commissioner, Federal Communications Commission, Remarks before the 6th Annual Americas Spectrum Management Conference (Oct. 13, 2017), http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db1013/DOC-347222A1.pdf.

concerns that the Commission's records may not be accurate.⁷⁴ For example, Wi-Fi Alliance explains that its preliminary assessment of the records in the Universal Licensing System ("ULS") shows that "some licensed FS stations are no longer in operation."⁷⁵ IEEE 802 notes that Higher Ground has completed an "exhaustive study" of the ULS databases for the 6 GHz band that could be useful to the Commission.⁷⁶ Without corrections, the Commission's databases may misidentify or mis-locate existing incumbents, making it difficult to protect them effectively. These errors could also reduce overall spectrum efficiency and increase costs, as unlicensed operators work to protect "non-existent operations."⁷⁷

The Commission's existing rules already provide a framework for ensuring a complete and correct database of 6 GHz licensees.⁷⁸ Because licensees are already required to update the Commission about technical changes to their operations, requesting updates need not be burdensome.⁷⁹ To ensure these changes are made, the NPRM should propose to require 6 GHz incumbents to make a simple electronic filing that confirms or corrects the locations and operational parameters of their 6 GHz operations.

⁷⁴ See IEEE 802 Comments at 6; Microsoft Comments at 12; Nokia Comments at 6; Wi-Fi Alliance Comments at 8; Wireless Broadband Industry Comments at 19–20.

⁷⁵ Wi-Fi Alliance Comments at 8.

⁷⁶ IEEE 802 Comments at 6.

⁷⁷ Wi-Fi Alliance Comments at 8.

⁷⁸ 47 C.F.R. §§ 1.947, 1.929.

⁷⁹ See IEEE 802 Comments at 6 (suggesting that licensees be asked about their intent to continue use and/or their phase-out plans).

CONCLUSION

Commenters from all parts of the wireless industry agree that there is an urgent need for additional mid-band spectrum for wireless broadband. Unlicensed technologies are driving economic growth, investment, and innovation—but continued success depends on the availability of additional spectrum resources to meet rapidly expanding demand for unlicensed technologies. The 6 GHz band offers an ideal opportunity to address this challenge. The Commission should, therefore, adopt an NPRM that proposes to open the entire 6 GHz band to unlicensed operations, seeks comments on the incumbent-protection proposal contained in these comments, and further maximizes the effectiveness of sharing by proposing to reform the database of incumbent licensees.

Respectfully submitted,

Apple Inc.
Broadcom Limited
Cisco Systems, Inc.
Facebook, Inc.
Google LLC
Hewlett Packard Enterprise
Intel Corporation
MediaTek Inc.
Microsoft Corporation
Qualcomm Incorporated

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